

A New Species of *Pseudorimula* (Fissurellacea: Clypeosectidae) from Hydrothermal Vents of the Mid-Atlantic Ridge

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ABSTRACT

Pseudorimula midatlantica new species is described from the Snake Pit hydrothermal field on the Mid-Atlantic Ridge. It is the second member of its genus, the type species being known from the Mariana Trough hydrothermal vents in the mid-Pacific. It differs from the type species in its hypertrophied development of the gonad, which displaces part of the space normally occupied by the foot on the left side; correspondingly, the posterior shell muscle of the type species is merged with the right shell muscle in *P. midatlantica*. Other differences are that it has three rather than six pairs of epipodial tentacles. The new species also provides evidence of faunal interchange between widely separated ridge systems.

Key words: Archaeogastropoda, Fissurellacea, Clypeosectidae; hydrothermal-vent limpets; Mid-Atlantic Ridge.

INTRODUCTION

The slit limpet genus *Pseudorimula* McLean, 1989, was based on a single species from hydrothermal vents at the Marina Trough in the mid-Pacific. Here I add to the genus a second species from the Mid-Atlantic Ridge, a ridge system for which other components of the fauna are largely undescribed. First indications of biota on the Mid-Atlantic Ridge came from camera tows and dredgings by the NOAA vessel *Researcher* at a hydrothermal field at 26°N (Rona *et al.*, 1986); mollusks were not reported. Mollusks from the Mid-Atlantic Ridge were first collected in 1988 by observers on the deep-submersible *Nautilie* at the Snake Pit hydrothermal field at 23°N. Spreading centers at these two sites on the Mid-Atlantic Ridge are diverging at a slower rate than those of the East Pacific (Rona *et al.*, 1986; Tunnicliffe, 1991).

Unusual features of the biota of the Snake Pit vents were noted by Mevel *et al.* (1989): "The characteristic feature of these hydrothermal sites is the amazing density of shrimps agglutinated on the chimneys; around the vents, the fauna consists of sea anemones, polychaetes,

gastropods, galatheids, mussels and zoarcid fish. The Snake Pit differs from the Pacific sites mostly by the absence of vestimentiferan worms, alvinellid and serpulid polychaetes and cephalopods."

This new species of *Pseudorimula* came to my attention after the original paper (McLean, 1989) was in press. It adds new limits to the morphology known in the family and provides an example of interchange between widely separated ridge systems. It is also the first mollusk to be documented from the Mid-Atlantic Ridge.

MATERIALS AND METHODS

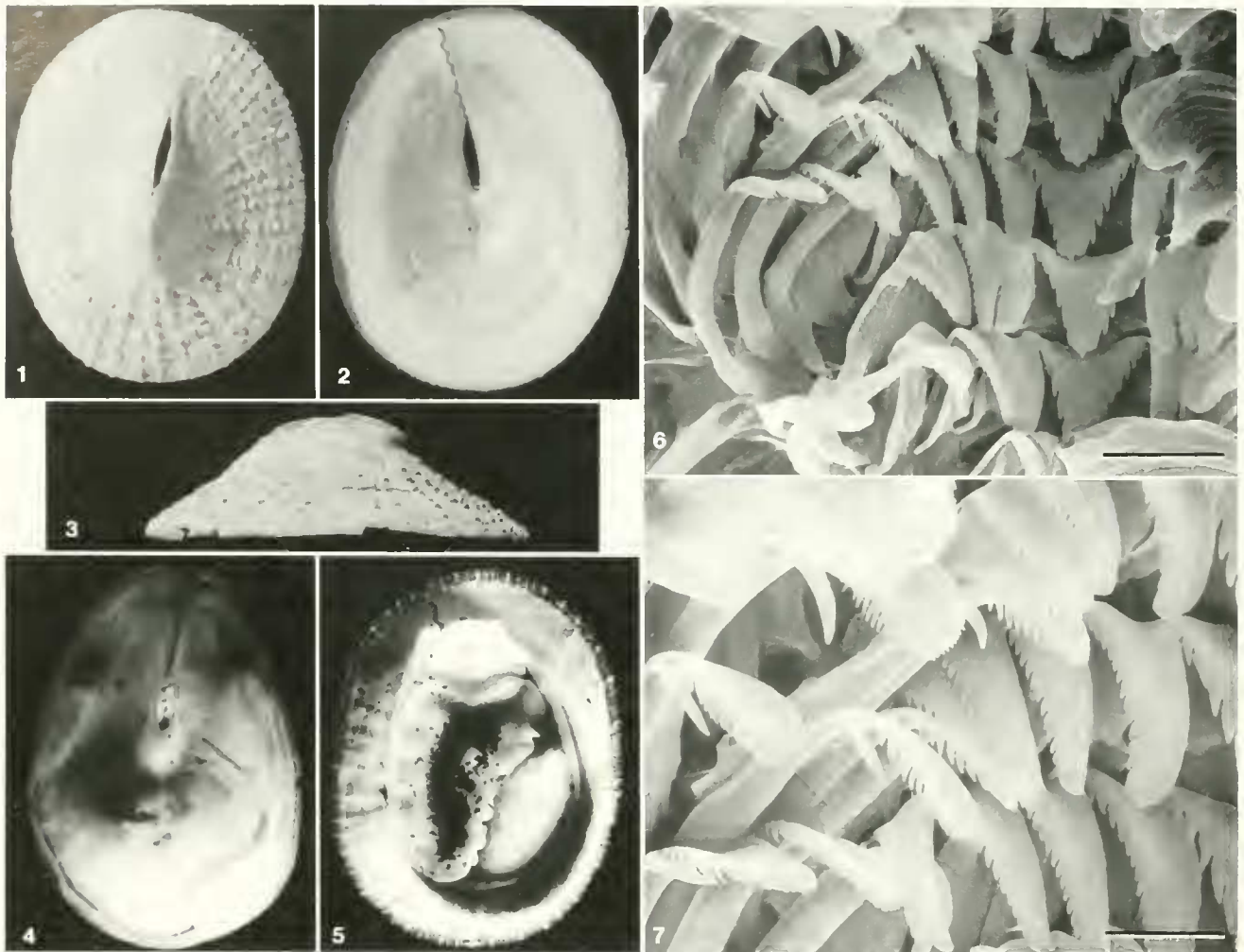
Specimens were collected by the French expedition HYDROSLAKE to the Mid-Atlantic Ridge, June-July 1988, and forwarded to me by Michel Segonzac of the Centre National de Tri d'Océanographie Biologique (CENTOB, IFREMER, Brest).

The illustrated radula was extracted from a preserved specimen after dissolution of tissues with room temperature 10% NaOH for 48 hours, washed in distilled water, air dried and coated with gold palladium for SEM examination.

Abbreviations for museums mentioned in the text are: MNHN, Muséum National d'Histoire Naturelle, Paris; LACM, Los Angeles County Museum of Natural History; USNM, National Museum of Natural History, Washington.

Suborder VETIGASTROPODA Salvini-Plawen, 1980
Superfamily FISSURELLACEA Fleming, 1922
Family CLYPEOSECTIDAE McLean, 1989

Clypeosectids differ from fissurellids in having a distinct radular plan, a reduced epipodium, a different pattern of shell musculature, and differences in the internal anatomy, as discussed in more detail by McLean (1989) and Haszprunar (1989). Haszprunar (1989) provided the an-



Figures 1–7. *Pseudorimula midatlantica* McLean, sp. nov. Nautilie dive HS10. Snake Pit hydrothermal field, Mid-Atlantic Ridge, 3,478 m. Holotype, MNHN. Anterior at top in vertical views. 1–3. External, internal, and left lateral views of shell. Length 8.1 mm. 4. Dorsal view of detached body showing left and right shell muscles. 5. Ventral view of body attached to shell, showing protruding gonad on left side of foot. Epipodial tentacles are concealed by the foot in this view. 6, 7. SEM views of radula of paratype. Scale bar for 6 = 20 μ m; scale bar for 7 = 10 μ m.

atomical evidence to justify the erection of a second family in the superfamily Fissurellacea.

On radular characters, the Fissurellidae differ from the Clypeosectidae in having a massive pluricuspid tooth that separates the lateral field of teeth from the marginal teeth. The pluricuspid tooth is lacking in the Clypeosectidae, in which the lateral and marginal teeth are strikingly similar in morphology. *Clypeosectus* McLean, 1989, was established for two species from eastern Pacific vents that have shells with an open slit deflected to the right. *Pseudorimula*, which is convergent in shell morphology with the fissurellid genus *Rimula* de France, 1827, has the slit closed at the margin.

Genus *Pseudorimula* McLean, 1989

Pseudorimula McLean, 1989:22. Type species: *Pseudorimula marianae* McLean, 1989.

Pseudorimula midatlantica McLean, spec. nov.
(figures 1–7)

Pseudorimula sp. McLean; Martin & Hessler, 1990:10; Tunnicliffe, 1991:349.

Description: Shell (figures 1–3) relatively large for family, maximum length 8.1 mm. Surface coated with rusty mineral deposits, under which periostracum yellowish brown, tightly adhering, projecting slightly past shell margin. Outline of aperture oval, margin of aperture nearly in same plane; highest elevation of shell at about one-half its length. Profile moderately high, height of holotype 0.34 times length. Apical whorl at two-thirds shell length from anterior end, slightly deflected to right; protoconch diameter 150 μ m. First teleoconch whorl smooth, rounded; slit arising two protoconch diameters away. Juvenile shells with open slit; in mature shells slit open about one-third length of anterior slope, strongly

deflected to right. Borders of foramen raised, except anteriorly, where slit is sealed in mature shells and its trace slightly depressed. Selenizone weakly depressed below slit border, additions to selenizone extending straight across. Sculpture of about 30 well-defined primary ribs with one to three secondary ribs of lesser prominence arising in interspaces. Concentric sculpture of fine growth lines, raised into sharp lamellar scales on crossing primary ribs. Shell interior opaque. Muscle scar well marked on shell interior; left and right arms swollen at anterior tips, but of uneven thickness posteriorly; right arm longer and retaining its thickness to its termination near midpoint; left arm shorter anteriorly and posteriorly, connecting to right arm through narrow band. Anterior pallial attachment scars well marked, extending close to suture bringing two anterior portions into contact anterior to foramen. Suture with zig-zag outline. Shell strengthened by thickened callus adjacent to suture and surrounding foramen.

Dimensions of holotype: Length 8.1, width 6.4, height 2.5 mm.

External anatomy (figures 4, 5): Anterior end of foot with double anterior edge marking opening of anterior pedal gland; foot posterior rounded; left side of foot displaced postero-laterally by projecting gonad. Cephalic tentacles contracted from preservation. Two posterior pairs of epipodial tentacles, on body wall midway between foot edge and thick border of mantle margin (posterior tentacles of right side in cavity abutting projecting gonad); single anterior pair, all with thick, joined bases, each with narrow projecting tips. Mantle skirt deeply emarginate, corresponding to foramen and seam in shell, edge of emargination with projecting papillae. Mantle skirt above head thin, nearly transparent. Shell muscles without inturned hooks; left muscle short in relation to right and truncate, right muscle extending more anteriorly than left, having thick posterior arm extending not quite to midpoint; left and right muscles joined by thin connective muscle near margin. Right ctenidium smaller than left; both ctenidia reduced, having filaments only on inner sides of axes.

Radula (figures 6, 7): Radular ribbon nearly symmetrical. Rachidian tooth with long overhanging tip, edges deeply serrate; shaft of rachidian short but broad at base. Four pairs of lateral teeth, similar in morphology to rachidian except much narrower; outer edges with fine serration, inner edges smooth; size of overhanging tips decreasing gradually away from rachidian. Marginal teeth numerous, with broad tips, edges finely and sharply serrate, serrations similar to those of laterals. Marginals and outer laterals with one long denticle on outer edge of shaft near overhanging tip.

Type locality: Snake Pit hydrothermal field, Mid-Atlantic Ridge (23°22'N, 47°57'W), 3,478 m.

Type material: Holotype and 20 paratypes from *Nautilite* dive HS10, 28 June 1988. Holotype MNHN; 16 paratypes MNHN; 2 paratypes LACM 2424, 2 paratypes

USNM 859485. The holotype is the only specimen in which both body and shell are in good condition, although the shell is heavily coated with mineral deposits. All other paratypes are smaller and completely decalcified so that they can not be measured. Bodies are mostly separated from the shell remnants and are somewhat mangled, although it is evident that the gonad protrudes on the left side in each. The radula was prepared from a detached body.

DISCUSSION

Pseudorimula midatlantica differs from *P. marianae* in having the right shell muscle longer than the left rather than having three separate muscles, a hypertrophied gonad that displaces the foot on the left side, a single pair rather than two pairs of anterior epipodial tentacles and two rather than four pairs of posterior epipodial tentacles. The two species can hardly be distinguished in shell profile or sculpture, although the holotype shell of *P. midatlantica* has an opaque interior, in contrast to the transparent condition in *P. marianae*. This, however, may be due to differences in preservation, including the treatment conditions that led to the decalcification of all paratype specimens of *P. midatlantica*.

In the original description of the genus *Pseudorimula*, I noted that the outer lateral teeth are morphologically similar to the inner marginal teeth, so much so that it is difficult to determine which are lateral teeth and which are marginal teeth. For *P. midatlantica* (figures 6, 7) I identify four pairs of lateral teeth by their more acute tips, compared to the broader terminations of the marginal teeth. Earlier (McLean, 1989: figs. I3C,D) I stated that *P. marianae* has five pairs of lateral teeth, but now revise that to four pairs based on re-examination of the original illustration.

Both of the two known species of *Pseudorimula* have differing features that set each apart from all other limpets: In *P. mariana* the shell muscle is inexplicably divided into three units, quite unlike the usual horseshoe-shaped muscle configuration in limpets of many families. In *P. midatlantica* the gonad is so hypertrophied that it displaces the foot on the left side; the shell muscle on the right side, where the foot remains large, is correspondingly longer. Which, then, of these two conditions is the more derived? We can assume that an ancestral species would have the usual horseshoe-shaped shell muscle and a gonad of normal size contained within the body cavity. Indeed, such a species may yet be discovered living on unexplored ridge systems. It is easy to understand the origin of the asymmetrical muscle pattern of *P. midatlantica* as an adjustment to gonad hypertrophication (in response to need for greater reproductive output) that eliminates space for muscle attachment on the left side, but there is no easy explanation for the presence of three separate shell muscles in *P. marianae*. If, however, the hypertrophied gonad of *P. midatlantica* were to revert to a normal size, the large right muscle would already be in place and the posterior muscle could

then be pinched off from the posterior tip of the right muscle, once there was no longer the need for a large right muscle.

The occurrence of the two species of *Pseudorimula* at such widely separate habitats as the Mariana Trough and the Mid-Atlantic Ridge is noteworthy but not unique. Martin and Hessler (1990) discussed "a growing body of evidence that there is a faunal connection between the Mariana vent area and the northern Mid-Atlantic Ridge." They mentioned similarities in the bythograeid crabs and gave three examples of genera represented in the two habitats, including *Pseudorimula* (as a personal communication from me), the shrimp genus *Chorocaris* (therein proposed), and a new genus of mussel (reported by Grassle, 1989). Martin and Hessler proposed that "the hydrothermal areas of the western Pacific and northern Mid-Atlantic Ridge were at one time connected via a series of active vent areas, not necessarily active simultaneously, that extended from the Mid-Atlantic Ridge south to the Atlantic-Indian Ocean Ridge, north along the Southwest Indian Ocean Ridge, Mid-Indian Ocean Ridge, and Southeast Indian Ocean Ridge, and finally north through the various spreading centers of the Indo-West Pacific."

Faunal connection between the Mariana Vents and those of the eastern Pacific were discussed by Hessler and Lonsdale (1991a,b). For vent limpets this applies only at the family level in the Clypeosectidae, as well as the Neomphalidae (McLean, 1990), but is exemplified at the species level by *Lepetodrilus elevatus* McLean, 1988, reported by McLean (1990) to occur at the Mariana vents as well as the east Pacific vents.

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LITERATURE CITED

- Grassle, J. F. 1989. A plethora of unexpected life. *Oceanus* 31:41-46.
- Haszprunar, G. 1989. New slit-limpets (Scissurellacea and Fissurellacea) from hydrothermal vents. Part 2. Anatomy and relationships. *Natural History Museum of Los Angeles County*, no. 408, 17 p.
- Hessler, R. R. and P. F. Lonsdale. 1991a. Biogeography of Mariana Trough hydrothermal vent communities. *Deep-Sea Research* 38:185-199.
- Hessler, R. R. and P. F. Lonsdale. 1991b. The biogeography of the Mariana Trough hydrothermal vents. *In*: J. Mauchling and T. Nemoto (eds.), *Marine biology, its accomplishment and future prospect*. Kokusen-sha (Japan), p. 165-182.
- Martin, J. W. and R. R. Hessler. 1990. *Chorocaris vandoverae*, a new genus and species of hydrothermal vent shrimp (Crustacea, Decapoda, Bresiliidae) from the Western Pacific. *Natural History Museum of Los Angeles County, Contributions in Science*, no. 417, 11 p.
- McLean, J. H. 1989. New slit-limpets (Scissurellacea and Fissurellacea) from hydrothermal vents. Part 1. Systematic descriptions and comparisons based on shell and radular characters. *Natural History Museum of Los Angeles County, Contributions in Science*, no. 407, 29 p.
- McLean, J. H. 1990. A new genus and species of neomphalid limpet from the Mariana vents with a review of current understanding of relationships among Neomphalacea and Peltospiracea. *The Nautilus* 104(3):77-86.
- Mevel, C., J. Auzende, M. Cannat, J. Donval, J. Dubois, Y. Fouquet, P. Gente, D. Grimaud, J. A. Karson, M. Segonzac, and M. Stievenard. 1989. La ride du Snake Pit (dorsale medio-Atlantique, 23°22'N) résultats préliminaires de la campagne HYDRO-SNAKE. *Comptes Rendus des Seances de l'Academie des Sciences, Paris, series 2*, 308:545-552.
- Rona, P. A., G. Klinkhammer, T. A. Nelsen, J. H. Trefry, and H. Elderfield. 1986. Black smokers, massive sulphides and vent biota at the Mid-Atlantic Ridge. *Nature* 321:33-37.
- Tunnicliffe, V. 1991. The biology of hydrothermal vents: ecology and evolution. *Annual Review of Oceanography and Marine Biology*, Margaret Barnes, ed., 29:319-407.